N° 13,521 A.D. 1902

Date of Application, 14th June, 1902
Complete Specification Left, 16th Mar., 1903—Accepted, 13th June, 1903

PROVISIONAL SPECIFICATION.

"Improvements in and relating to Coherers."

We, Oliver Joseph Lodge, of Mariemont, Edgbaston, Birmingham, in the County of Warwick, D.Sc., F.R.S., Principal of the University, Birmingham, Alexander Muirhead, of the Lodge, Shortlands, in the County of Kent, D.Sc., Telegraph Engineer, and Edward Ernest Robinson, of Fernlea, Willow Avenue, Edgbaston, Birmingham, in the County of Warwick, Assistant to the Principal of the University of Birmingham, do hereby declare the nature of this invention to be as follows:—

Our invention relates to coherers such as are employed as detectors or receivers in systems of wireless telegraphy.

In coherers as hitherto constructed it has been customary to depend on the natural film of oxide or other material which exists on most metals to act as the intervening layer preventing full conduction between a pair of metal pieces brought into light contact in some random or unmetrical manner. Sometimes a contact between a spring and a point has been utilized as disclosed by the Specification of prior Letters Patent granted to one of us No. 11575 of 1897. More usually the accidental contact between the particles in an assemblage of metal filings as suggested by Branly has been employed.

In each case the electrical disturbance due to the impact of ethereal waves has resulted in "coherence" and increased conductivity in the coherer, and decoherence has been occasioned by agitation or tapping.

According to our present invention we propose to use a more definite kind of film and to obtain the necessary light pressure in a more definite manner. To this end we employ as the film a thin layer of oil or similar substance interposed between two metallic surfaces and frequently renewed; and for the pressure we depend on the hydrostatic pressure of a column of liquid, preferably employing mercury as one of the two metals, the other one being solid and plunged to a given depth in the mercury. To apply the film of oil, a thick layer of oil is laid upon the mercury and into this the solid metal preferably in the form of a platinum or iron point is immersed to a small depth.

We find that so long as a feeble voltage is applied, say three-tenths of a volt or less, the film is strong enough permanently to resist the passage of a current; but that whenever the electromotive force rises to, say one volt or more, as it does at once if a spark has occurred in the neighbourhood, or if electric waves have been received from a distant station, then the film is broken down, easy conduction is caused and a signal is recorded.

To restore the continuity of the film, again, mere motion is often sufficient, but the securest plan is to withdraw the metal point from the mercury into the supernatant layer of oil and immediately thereafter to plunge it back into the mercury.

This withdrawal and re-immersion is very easily accomplished automatically either by mechanical or electrical means or by the action of the current which the broken-down film itself transmits, or otherwise, the re-immersion of the point following instantly on the cessation of the current by the restoration of the film. Obviously this motion may be effected in any appropriate manner, whether by rotation, or translation, or vibration.

For instance the immersed metal might be the rim of a rotating wheel, or it

[*Price 8d.*]

BIRMINGHAM FREE LIBRARIES

might be supported on the prong of a vibrating tuning fork, or it might be simply depressed into the mercury and withdrawn therefrom by attachment to the siphon-recorder coil, or other moving part affected electromagnetically by the signalling current.

The passage of a comparatively strong momentary current across the broken-down film is no detriment, since the film being liquid can be completely and certainly renewed.

The metal used should be clean, free from any film of its own, and not liable to amalgamate with mercury.

Dated this 14th day of June 1902.

A. F. SPOONER,
323 High Holborn, London, Agent for the Applicants.

COMPLETE SPECIFICATION.

"Improvements in, and relating, to Coherers."

We, Sir OLIVER JOSEPH LODGE, of Mariemont, Edgbaston, Birmingham, in the County of Warwick, Knight, D.Sc., F.R.S., Principal of the University, Birmingham, ALEXANDER MUIRHEAD, of The Lodge, Shortlands, in the County of Kent, D.Sc., Telegraph Engineer, and EDWARD ERNEST ROBINSON, of Fernlea, Willow Avenue, Edgbaston, Birmingham, in the County of Warwick, Assistant to the Principal of the University of Birmingham, do hereby declare the nature of this invention and in what manner the same is to be performed to be particularly described and ascertained in and by the following statement:—

Our invention relates to coherers, such as are employed as detectors or receivers in systems of wireless or ethereal telegraphy.

In coherers as hitherto constructed it has been customary to depend on the natural film of oxide or other material, which exists on most metals, to act as the intervening layer preventing full conduction between a pair of metal pieces brought into light contact in some random or unmetrical manner. Sometimes a contact between a spring pressing lightly on a point has been utilized, as disclosed by the Specification of prior Letters Patent, granted to one of us, No. 11575 of 1897, but more usually the accidental light contact between the particles in an assemblage of metal fillings, as suggested by Branly, has been employed.

In each case the electrical disturbance, due to the impact of ethereal waves, has resulted in "coherence" and increased conductivity in the coherer, and "decoherence" has been occasioned by agitation or tapping.

According to our present invention we propose to use a more definite kind of film and to obtain the necessary light pressure in a more definite manner. To this end we employ, as the film, a thin layer of paraffin oil or similar insulating substance interposed between two metallic or conducting surfaces and frequently renewed; and for the pressure we depend on the hydrostatic pressure of a column of liquid, preferably employing mercury or other conducting fluid as one of the two conductors, the other one being solid and plunged to a given depth in the mercury or its equivalent. To apply the film of oil, a layer of oil is placed upon the mercury, so that when the solid metal, preferably in the form of a platinum or iron point or a metallic wheel, is immersed to a small depth into the mercury it carries down with it a superficial film of oil.

We find that so long as a feeble voltage is applied (say three-tenths of a volt or less) the film is strong enough permanently to resist the passage of a current, but that whenever the electromotive force rises to, say, one volt or more, as it does at once for an instant if a spark has occurred in the neighbourhood, or if electric waves have been received from a distant station, then the film is broken down, easy conduction is caused, and a signal is recorded.

To restore the continuity of the film again, motion is sufficient, and one of the simplest plans is to withdraw the metal point from the mercury into the supernatant layer of oil, and immediately thereafter to plunge it back into the mercury.

This withdrawal and re-immersion is very easily accomplished automatically either by mechanical or electrical means, or by the action of the current which the broken-down film itself transmits, or otherwise, the re-immersion of the point following instantly on the cessation of the current by the restoration of the film. Obviously this motion may be effected in any appropriate manner, whether by rotation, or translation, or vibration.

For instance, the immersed conductor might be the rim of a rotating wheel, or it might be supported on a vibrating body, such as the prong of a tuning fork, or it might be simply depressed into the mercury and withdrawn therefrom by attachment to the siphon-recorder coil, or other moving part affected electro-magnetically by the signalling current.

The passage of a comparatively strong momentary current across the broken-down film is no detriment, since the film, being liquid, can be completely and certainly renewed.

The metal used should be clean, free from any film of its own, and not liable to amalgamate with mercury.

In the accompanying drawings, which are diagrammatic representations, Figure 1 shows our new coherer attached to a recorder coil in the "coherer" circuit; Figure 2 represents it attached to a tuning-fork; and Figures 3 and 4 illustrate the wheel-form of it, Figure 3 being an elevation and Figure 4 a plan thereof.

Referring generically to the diagrams, one of the conducting surfaces or terminals of the coherer *a* preferably takes the form of a globule or pool of mercury *b* contained in a trough *c*, the height of which may be adjustable by suitable means, as, for example, an adjustment screw *d*. *e* denotes the layer of paraffin oil or like fluid insulator. The other conductor *f* of the coherer may either be arranged to dip into, and out of, the mercury through the supernatant fluid insulator, or some portion of it may be constantly passing from the fluid insulator into the mercury, and from the latter into the insulator again.

In the first example this metallic surface *f* may take the form of a dipping needle (see Figures 1 and 2) and in the second example it may conveniently take the form of a rotating disc (see Figure 3).

In each instance it will be seen that the conducting surface *f* enters the mercury *b* with a film of the fluid insulator *e* adhering to it and that, by reason of the motion imparted to such conducting surface, such film is being constantly renewed.

The motion given to the part *f* may be obtained from any source and by any suitable instrumentality, either from the coherer circuit itself, or extraneously.

Referring now specifically to Figure 1, *f* is a steel or platinum needle attached to an arm *g* carried by a recorder coil *h*, *i.e.* a rectangular coil of insulated copper wire pivoted or suspended between the poles of a magnet N, S. Beneath the needle is placed the trough *c* containing the mercury *b*. The layer of paraffin oil *e* is poured upon the mercury *b* and the trough adjusted by means of the screw *d* until the needle-point *f* just enters the mercury *b*. A suitable portion of the voltage of the single cell *i* is applied to the coherer *a* by shunting the cell with a resistance *j* and making connexions at one pole of the cell and at an intermediate point on the shunt, or in any other convenient way, or by employing a cell or source of low voltage.

In the figure, the cell *i* is shown joined up between the mercury pole *b* of the coherer and one terminal of the coil *k* of a siphon-recorder. The recorder *k* is in series with the recorder coil *h* and the needle *f* of the coherer connected to one terminal of the cell or battery *i*.

So long as the amount of voltage applied to the coherer is about three-tenths of a volt or less, the thin film of oil between the needle-point *f* and the mercury *b* will prevent the passage of an appreciable current through the coils *h*, *k*; but on the arrival of ethereal waves from a distance, the voltage between the needle point and the mercury is instantaneously and temporarily increased sufficiently to break down the oil film and allow a current to flow across it from the battery *i*; the result being a deflexion of the recorder coil *k* producing a signal on the tape *l*, and a deflexion of the coil *h* in the direction to raise the needle point *f* out of the mercury *b*. This withdrawal of the needle-point *f* from the mercury *b* and re-immersion in the same on the cessation of the current through the coil *h* restores the continuity of the thin film between the needle-point and the mercury and prepares the coherer for a succeeding electric wave or signal.

In Figure 2 the needle-point *f* is shown attached to a vibrating body; the figure illustrates it so attached to one of the prongs of a tuning fork *m* which is kept vibrating by means of an alternating or intermittent current (generated by an alternator *n* or self-acting intermitter as usually arranged) flowing through a bobbin of wire *o* placed between the prongs of the fork.

The vibration of the needle-point *f* in the mercury *b* thus produced restores the continuity of the film of oil immediately after the breaking down of the latter by ethereal waves from a distance, or a spark in the neighbourhood.

In Figures 3 and 4 the conducting part *f* is shown in the form of a disc or wheel slightly immersed in the mercury *b*. The constant rotation of the wheel, effected by such means as a clockwork train represented diagrammatically at *p*, brings about the restoration of the continuity of the oil film between the wheel and the mercury after the cohering action of ethereal waves received from a distance, as in the two former cases (Figures 1 and 2). The amount of pressure of the mercury upon the disc or wheel is regulated by means of the screw *d* fixed beneath the trough which contains the mercury, so as to raise or lower it and so regulate the immersion.

We prefer, in the form of our invention just described, to employ a device adapted to clean or wipe the edge of the conductor *f* before it enters the mercury *b*, and thus obviate the prejudicial affects of stray disturbances upon the recorder slip. This device may, as shown, conveniently consist of a pad *q* of felt or other appropriate material mounted in light contact with the conductor *f*, for which purpose it is secured to a spring *r* arranged as illustrated. In this way the object above mentioned is simply attained.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:—

1. In combination, in a coherer, two conducting surfaces, a film of fluid insulating material between such surfaces capable of being broken down upon the occurrence of an ethereal wave in the neighbourhood, and means serving to renew such film.

2. In combination, in a coherer, two conducting surfaces, a film of fluid insulating material between such surfaces capable of being broken down upon the occurrence of an ethereal wave in the neighbourhood, and automatic means serving to renew such film.

3. In combination, in a coherer, two condensing surfaces, a film of fluid insulating material between such surfaces, and means serving to impart motion to one of the conducting surfaces for the purpose of restoring the continuity of the film whenever it is broken down by an ethereal wave.

4. In combination, in a coherer, two conducting surfaces one of which is solid and the other of which is fluid, a film of insulating material between such surfaces capable of being broken down upon the occurrence of an ethereal wave in the neighbourhood, and means serving to renew such film.

5. In combination, in a coherer, two conducting surfaces one of which is solid and the other of which is fluid, a layer of fluid insulating material upon the fluid conductor, means serving to immerse the solid conductor into the fluid one so that a

film of the fluid insulating material is between the conductors, and means serving to renew such film whenever it is broken down by an ethereal wave.

6. In combination, in a coherer, two conducting surfaces one of which is solid and the other of which is mercury, a layer of fluid insulating material upon the mercury, means serving to immerse the solid conductor into the mercury so that a film of the fluid insulating material is between the conductors, and means serving to renew such film whenever it is broken down by an ethereal wave.

7. In combination, in a coherer circuit, a battery, a recorder coil, and a coherer comprising two conducting terminals separated by a renewable film of fluid insulating material, one of the conducting terminals being carried by, or attached to, the recorder coil.

8. In combination, in a coherer circuit, a battery, and a coherer comprising two conducting terminals separated by a renewable film of fluid insulating material.

9. In combination, in a coherer circuit, a battery, a resistance shunt around the battery, and a coherer comprising two conducting terminals separated by a renewable film of fluid insulating material.

10. In combination, in a coherer circuit, a battery, a coherer comprising two conducting terminals separated by a film of fluid insulating material, and means, actuated either from the coherer circuit itself, or extraneous from such circuit, serving to restore the continuity of such film whenever it is broken down by an ethereal wave.

11. In combination, in a coherer circuit, a battery, a coherer comprising two conducting terminals separated by a film of fluid insulating material, means actuated from the coherer circuit itself serving to restore the continuity of such film whenever it is broken down by an ethereal wave, and a siphon-recorder in series in the said circuit.

12. In combination, in a coherer, two conducting surfaces, a film of fluid insulating material between such surfaces, a vibrating body to which one of the conducting surfaces is attached, and means to vibrate the body whereby the continuity of the film is restored after having been broken down by an ethereal wave.

13. In combination, in a coherer, a pool of mercury forming one terminal of the coherer, a layer of fluid insulating material above the mercury, a disc forming the other terminal of the coherer located partly within the mercury and the fluid insulating material respectively, and means to move the disc so that the continuity of the film is restored after having been broken down by an ethereal wave.

14. In combination, in a coherer, a trough, a pool of mercury forming one terminal of the coherer in such trough, a layer of fluid insulating material above the mercury, a disc forming the other terminal of the coherer located partly within the mercury and the fluid insulating material respectively, and means to rotate the disc so that the continuity of the film is restored after having been broken down by an ethereal wave.

15. Coherers and coherer circuits constructed, arranged, and operating substantially as described, and illustrated in the accompanying drawings.

Dated this 16th day of March 1903.

A. F. SPOONER,
323 High Holborn, London. Agent for the Applicants.

Redhill: Printed for His Majesty's Stationery Office, by Love & Malcomson, Ltd.—1903.

ERRATA.

SPECIFICATION No. 13,521 A.D. 1902.

Page 2, line 31, *for* " fillings " *read* " filings"
,, 4, ,, 46, *for* " condensing " *read* " conducting "

PATENT OFFICE,
15*th December*, 1904.

A.D. 1902. June 14. No 13,521.

LODGE & *others'* Complete Specification. (1 SHEET)

Fig. 1.

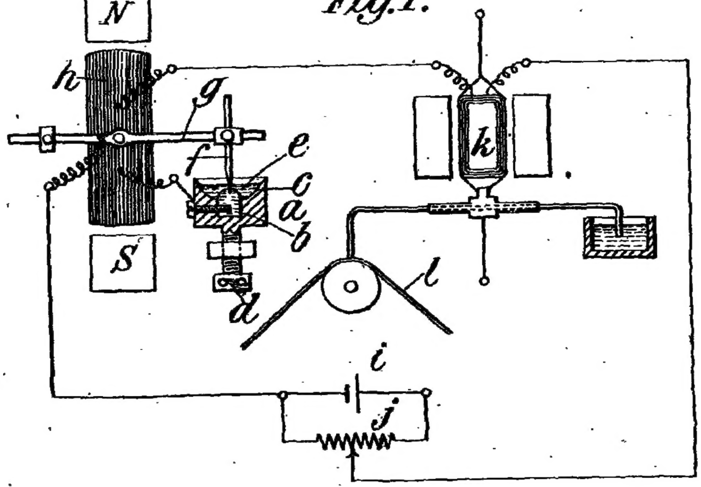


Fig. 2.

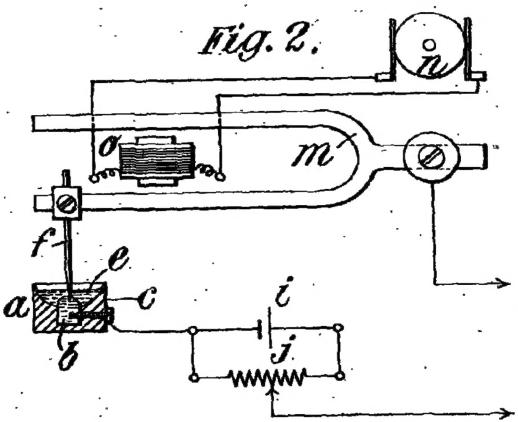


Fig. 4.

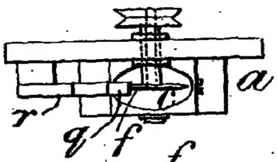
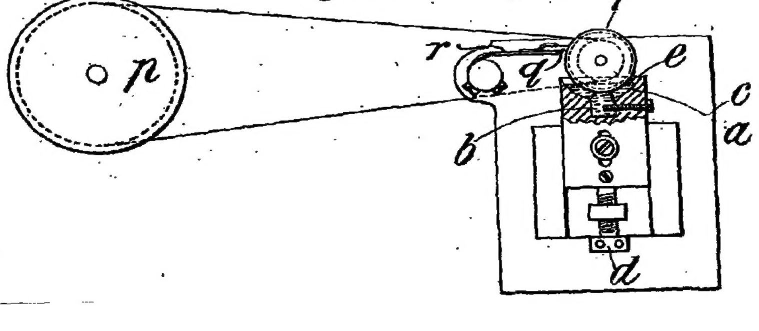


Fig. 3.



[This Drawing is a reproduction of the Original on a reduced scale]

BIRMINGHAM FREE LIBRARIES